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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1. 53(b))

Attorney Docket No.	NREL 99-10
First Inventor	Howard M. Branz
Title	Method for Improving the Stability of Amorphous Silicon
Express Mail Label No.	EJ 200304395 US

APPLICATION ELEMENTS

See *MPEP* chapter 600 concerning utility patent application contents.

ADDRESS TO: Assistant Commissioner for Patents
Box Patent Application
Washington, DC 20231

1 [X] Fee Transmittal Form (e.g., PTO/SB/1 7)
(Submit an original and a duplicate for fee processing)

2 [X] Applicant claims small entity status.
See 37 CFR 1.27.

3 [X] Specification [Total Pages 12]
(preferred arrangement set forth below)
- Descriptive title of the invention
- Cross Reference to Related Applications
- Statement Regarding Fed sponsored R & D
- Reference to sequence listing, a table, or a computer program listing appendix
- Background of the Invention
- Brief Summary of the Invention
- Brief Description of the Drawings *(if* Red)
- Detailed Description
- Claim(s)
- Abstract of the Disclosure

4 [X] Drawing(s) (35 U.S. C. 1 13) [Total Sheets 3]

5 Oath or Declaration [Total Pages 2]
a. [X] Newly executed (original or copy)
b. [ ] Copy from a prior application (37 CFR 1.63 (d))
(for continuationidivisional with Box I 8 completed)
1 [ ] DELETION OF INVENTOR(S)
Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1 63(d)(2) and 1 33(b)

6 [X] Application Data Sheet. See 37 CFR 1.76

7. [ ] CD-ROM or CD-R in duplicate, large table or Computer Program (Appendix)

8. Nucleotide and/or Amino Acid Sequence Submission *(if applicable, all necessary)*
a. [ ] Computer Readable Form (CRF)
b Specification Sequence Listing on.
1 [ ] CD-ROM or CD-R (2 copies); or
11 [ ] paper
c [ ] Statements verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

9 [X] Assignment Papers (cover sheet & document(s))
10 [ ] 37 CFR 3 73(b) Statement *(when there is an assignee)* [X] Power of Attorney
11. [ ] English Translation Document *(if* applicable)
12 [X] Information Disclosure Statement (IDS)/PTO-1449 [X] Copies of IDS Citations
13 [ ] Preliminary Amendment
14 [X] Return Receipt Postcard (MPEP 503) *(Should be specifically itemized)*
15 [ ] Certified Copy of Priority Document(s) *(if foreign priority is claimed)*
16 [ ] Request and Certification under 35 U.S.C. 122 (b)(2)(13)(i) Applicant must attach form PTO/SB/35 or its equivalent.
17. [ ] Other

18 If a CONTINUING APPLICATION, *check appropriate box, and supply the requisite information below and in a preliminary amendment, or in an Application Data Sheet under 37 CFR 1. 76 ,*

[ ] Continuation [ ] Divisional [ ] Continuation-in-part (CIP) of prior application No.: ____ / ____

Prior application information Examiner ____ Group Art Unit ____

For CONTINUATION OR DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 5b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

1 CORRESPONDENCE ADDRESS

[ ] Customer Number or Bar Code Label (Insert Customer No or Attach bar code label here) 23712 or [ ] Correspondence address below

PATENT TRADEMARK OFFICE

Name	Paul J. White				
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Name (Print/Type)	Paul J. White	Registration No. (Atttorney/Agent)	30,436
Signature	Paul J. White	Date	November 16, 2000

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FEE TRANSMITTAL

Patent fees are subject to annual revision on October 1.
These are the fees effective October 1, 1997.
Small Entity payments must be supported by a small entity statement, otherwise large entity fees must be paid. See Forms PTO/SB/09-12
See 37 C.F.R. §§ 1.27 and 1.28.

TOTAL AMOUNT OF PAYMENT ($) 355.00

Complete if Known	
Application Number	Not Yet Accorded
Filing Date	Not Yet Accorded
First Named Inventor	Howard M. Branz
Examiner Name	Not Yet Accorded
Group / Art Unit	Not Yet Accorded
Attorney Docket No.	NREL 99-10

METHOD OF PAYMENT (check one)

1. ☒ The Commissioner is hereby authorized to charge indicated fees and credit any over payments to:

Deposit Account Number: 14-0460

Deposit Account Name: National Renewable Energy Lab.

☒ Charge Any Additional Fee Required Under 37 C F R §§ 1 16 and 1 17 ☐ Charge the Issue Fee Set in 37 C F R § 1 1 8 at the Mailing of the Notice of Allowance

2. ☐ **Payment Enclosed:** ☐ Check ☐ Money Order ☐ Other

FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
101	790	201	395	Utility filing fee	355.00
106	330	206	165	Design filing fee	
107	540	207	270	Plant filingfee	
108	790	208	395	Reissue filing fee	
114	150	214	75	Provisional filing fee	

SUBTOTAL(I) ($) 355.00

2. EXTRA CLAIM FEES

	Extra Claims		Fee from below	Fee Paid
Total Claims 17	-20**--= 0	X	$ 9	0
Independent Claims 1	-3**--= 0	X	$40	0
Multiple Dependent				0

*or number previously paid, if greater; For Reissues, see below

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description
103	22	203	11	Claims in excess of 20
102	82	202	41	Independent claims in excess of 3
104	270	204	135	Multiple dependent claim, if not paid
109	82	209	41**	Reissue independent claims over original patent
110	22	210	11**	Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) ($)

FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
105	130	205	65	Surcharge - late filing fee or oath	
127	50	227	25	Surcharge - late provisional filing fee or cover sheet	
139	130	139	130	Non-English specification	
147	2,520	147	2,520	For filing a request for reexamination	
112	920*	112	920*	Requesting publication of SIR prior to Examiner action	
113	1,840*	113	1,840*	Requesting publication of SIR after Examiner action	
115	110	115	55	Extension for reply within first month	
116	400	216	200	Extension for reply within second month	
117	950	217	475	Extension for reply within third month	
118	1,510	218	755	Extension for reply within fourth month	
128	2,060	228	1,030	Extension for reply within fifth month	
119	310	219	155	Notice of Appeal	
120	310	220	155	Filing a brief in support of an appeal	
121	270	221	135	Request for oral hearing	
138	1,510	138	1,510	Petition to institute a public use proceeding	
140	110	240	55	Petition to reive - unavoidable	
141	1,320	241	660	Petition to reive - unintentional	
142	1,320	242	660	Utility issue fee (or reissue)	
143	450	243	225	Design issue fee	
144	670	244	335	Plant issue too	
122	130	122	130	Petitions to the Commissioner	
123	50	123	50	Petitions related to provisional applications	
126	240	126	240	Submission of Information Disclosure Stmt	
581	40	581	40	Recording each patent assignment per property (times number of properties)	
146	790	246	395	Filing a submission after final rejection (37 CFR 1. 1 29(a))	
149	790	249	395	For each additional invention to be examined (37 CFR 1 1 29(b))	
Other fee (specify)					
Other fee (specify)					

*Reduced by Basic Filing Fee Paid SUBTOTAL (3) ($)

SUBMITTED BY				Complete (it applicable)	
Typed or Printed Name	Paul J. White, Senior Patent Counsel			Reg. Number	30,436
Signature	Paul J. White	Date	11/16/00	Deposit Account User ID	

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NREL/99-10

METHOD FOR IMPROVING THE STABILITY OF AMORPHOUS SILICON

By

Howard M. Branz

METHOD FOR IMPROVING THE STABILITY OF AMORPHOUS SILICON

CROSS REFERENCE TO RELATED APPLICATIONS

Pursuant to 35 U.S.C 119(e) Applicant claims the benefit of U.S. Ser. No. 60/165,751 filed 16 November 1999, a 35 U.S.C. 111(b) Application.

CONTRACTUAL ORIGIN OF THE INVENTION

The United States Government has rights in this invention pursuant to Contract No. DE-AC36-99GO10337 between the United States Department of Energy and the Midwest Research Institute.

BACKGROUND OF THE INVENTION

Field of the Invention.

This invention relates to hydrogenated amorphous silicon materials, and, in particular, it relates to a method of making hydrogenated amorphous silicon films which are characterized by an improved stability to metastable degradation and useful in amorphous silicon devices.

Description of the Related Art.

An amorphous silicon device, such as a silicon solar cell, is comprised of a body of hydrogenated amorphous silicon (a-Si:H) material, which can be formed in a glow discharge of silane or other chemical vapor deposition techniques. Such cells can be of the type described in U.S. Pat. No. 4,064,521 entitled: Semiconductor Device Having a Body of Amorphous Silicon,

issued to D.E. Carlson on 20 December 1977. Amorphous hydrogenated silicon based device technology is currently the leading candidate for large area, low-cost photovoltaic applications.

For solar cells, the basic device structure is a single p-i-n junction or an n-i-p junction in which all layers are traditionally amorphous and are made in a continuous plasma deposition process. The substrate of the solar cell can be made of glass or a metal, such as aluminum, niobium, titanium, chromium, iron, bismuth, antimony or steel. A metallic contact can be formed on the back of the substrate.

However, since its discovery in 1977, a distinct disadvantage in application of these materials in devices has heretofore been the problem of light-induced metastability of the a-Si:H films themselves. See, Staebler, D.L. and Wronski, C. R., Appl. Phys,. Lett., 31, 1977, 292. Briefly, the exposure of device-quality a-Si:H films to light or excess carriers results in an increase in the density of neutral threefold-coordinated dangling-bond (DB) defects by one to two orders of magnitude. The excess in defects reduces carrier lifetimes and photoconductivity in the films which sharply limits the usefulness of a-Si:H as an inexpensive semiconductor material.

A new model of light-induced metastability (Staebler-Wronski effect) in a-Si:H has more recently been disclosed. There, it is postulated that when two mobile H atoms, generated by photo-induced carriers, collide they form a metastable-immobile-complex which contains two Si-H bonds. Excess metastable dangling bonds remain at the uncorrelated sites, from which the colliding hydrogen molecules were excited. This quantitative model accounts for many of the experimental observations which relate to the microscopic nature of the degradation problem and the associated kinetics of light-induced-defect-creation under various conditions. See, Branz, H., Solid State Communications, Vol. 105, No. 6, pp. 387-391, 1998.

It is well known that the light-induced DB defects are metastable because they can be reversed. In the prior art, one method of reversing metastability includes annealing the films for 2 hours at temperatures greater than 150° C. Another way of annealing light-induced changes in the dark conductivity and photoconductivity of a-Si:H thin films involves the ultraviolet (UV) irradiation (wavelength ≅ 254 nm) of the films at room temperature. With this annealing process, a problem exists in that although the bulk photoconductivity of the film is improved, the UV irradiation is mostly absorbed near the top surface of the films and causes considerable surface damage. G. Ganguly, et al., Appl. Phys. Lett. 55, 1975 (1989). Further, illumination will cause Staebler-Wronski degradation of all amorphous silicon after such reversal treatments. Thus, what is needed is a process which, unlike the foregoing reversal methods, produces device-quality a-Si:H films which are highly resistant to metastable degradation without deleterious surface damage and thereby demonstrate an improvement in stability under light exposure or excess carrier conditions when used in amorphous silicon devices.

SUMMARY OF THE INVENTION

It is accordingly an object of the invention to provide novel hydrogenated amorphous silicon films which are characterized by an improved resistance to metastable degradation.

It is another object of the invention to provide a novel method for producing device-quality a-Si:H films which are highly resistant to metastable degradation and thereby demonstrate an improved stability when exposed to light or excess carriers.

It is yet another object of the invention to provide amorphous silicon devices which, through use of the novel a-Si:H films made according the method herein, are characterized by an improvement in stability when used under light or excess carrier conditions.

Briefly, to overcome the problems associated with the prior art methods and in accordance with the purpose of the invention, as embodied and broadly described herein, the invention is intended to provide a method of producing amorphous hydrogenated silicon films which are resistant to metastable degradation, the method comprising the steps of growing a hydrogenated amorphous silicon film, the film having an exposed surface, illuminating the surface using an essentially blue or ultraviolet light to form high densities of a light induced defect near the surface, and etching the surface to remove the defect.

Additional advantages of the present invention will be set forth in part in the description that follows and in part will be obvious from that description or can be learned from practice of the invention. The advantages of the invention can be realized and obtained by the method particularly pointed out in the appended claims.

DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and which constitute a part of the specification, illustrate at least one embodiment of the invention and, together with the description, explain the principles of the invention.

Figure 1 is a flow diagram of the process according to the invention.

Figure 2 is a graph showing an improvement in the stability of an a-Si:H film prepared using the process of the invention.

Figure 3 is a schematic diagram of a Schottky barrier photovoltaic cell having an amorphous hydrogenated silicon material made according to the method herein and deposited on a stainless steel substrate in accordance with Example 2.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Unless specifically defined otherwise, all technical or scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. Although any methods and materials similar or equivalent to those described herein can be used in the practice or testing of the present invention, the preferred methods and materials are now described.

The invention provides a process for improving a-Si:H stability by increasing the density of metastable two-hydrogen complexes without simultaneously increasing the dangling-bond density. Referring now to the drawing figures, in Figure 1 it is shown generally at **10** a device comprised of an a-Si:H film **2** deposited on a suitable substrate **4**, such as glass. The film **2** may be incorporated into a solar cell, transistor, sensor or any other device utilizing a-Si:H or it may be an alloy based on a-Si:H, such as a-SiGe:H or a-SiC:H. The device **10** may be prepared according to any method well known in the art. For example, a-Si:H devices **10** may be prepared by the glow discharge decomposition of 10 sccm of pure silane at a chamber pressure of 0.3 Torr with radio frequency power of 5 W (13.56 MHz frequency) onto substrates **4** held at 250° C. Metal contacts **3** are also provided for measurement of photoconductivity.

An excess metastable ($M(Si\text{-}H)_2$) region **2c** is created using illumination of the a-Si:H film layer **2** with blue or ultraviolet light **5**, as shown through cross section **A** of the device

10. The illumination step increases the dangling-bond density in damaged region **2a**, but, at the same time, gently drives excess mobile hydrogen **2b** into the bulk of the film **2** where it passivates dangling-bonds and forms the two-hydrogen complexes M $(Si\text{-}H)_2$ in the bulk region **2c**. An etching step is then used to remove the damaged surface layer **2a**, leaving behind a hydrogen-enriched film **2c**. The illumination and etch steps may be repeated many times, and can be done either in a deposition chamber or outside it after deposition of the film **2** itself.

In some applications the film must be carefully handled subsequent to the ultraviolet light illumination processing step. For example, annealing for about 1 hour at 200° C or more will cause hydrogen to redistribute within the film, and this redistribution of hydrogen will annul the improvements achieved with the ultraviolet-light-illumination and etch steps, according to the method of the invention. Moreover, when using the film in device applications, thermal treatment of the doped contacts or other layers subsequent to the illumination and etch steps is desirably limited to temperatures in a range of less than 150° C.

Referring again to Figure 1, when a film prepared according to the method of the present invention is used under illumination conditions, mobile hydrogen **2c** is released from the metastable two-hydrogen complexes, and this release stabilizes the material against excessive metastable dangling bond formation (Staebler-Wronski effect).

The following examples illustrate the manner in which the amorphous hydrogenated silicon materials in accordance with the method of the present invention can be made and used in device quality applications.

EXAMPLE 1

Referring once again to Figure 1 a device **10** having an a-Si:H layer **2** approximately 4800Å in depth was cut in half along cross section **A**. One half of the sample was illuminated for 40 minutes with about 38 mW/cm $^{-2}$ of UV light obtained from a Hg-Xe compact arc lamp light source filtered through a 335 nm filter with a 100 nm wide band pass. The other half of the sample was used as the control without illumination. Each half was then etched in a 20% solution of NaOH in water for about 3 minutes in order to remove the upper 700Å of the surface, leaving an a-Si:H layer(s) **2c** of approximately 4100Å. The layers **2c** were illuminated continuously by 100 mW/cm $^{-2}$ of red light from a white source filtered by a 650 nm filter with a 100 nm wide bandpass. Periodic photoconductivity measurements were made under this same red light.

In Figure 2, the photoconductivity (S/cm) for each of the above samples is graphically illustrated as a function of time. The dashed line represents the measured results for the UV illuminated sample, and the solid line represents the control results. From this graph, it is easily observed that the UV illuminated and etched sample was more stable over time.

EXAMPLE 2

This example illustrates an improved resistance, measured as the function of open-circuit voltage, to metastable degradation under light-soaking conditions using Schottky barrier photovoltaic cells. Referring now to Figure 3, it is shown generally a schematic diagram of the Schottky cell **20** as deposited on a stainless steel substrate **21**. Here, a 500Å thick n-layer **22** was deposited using plasma-enhanced chemical vapor deposition (PECVD) from PH_3, H_2 and SiH_4

source gasses. A 3000Å thick i-layer **23** was also PECVD deposited from a SiH_4 source gas. A portion of this thin film **23** was then treated with ultraviolet light for 1 hour using the light source and intensity conditions set forth above. Then, an overlapping portion of the sample surface was etched in a 20% solution of NaOH in water for about 1 minute to remove about 700Å from the top i-layer **23** surface. A portion of the sample which was not etched had been treated with ultraviolet light in order to serve as an experimental control. Semitransparent Pd top-contacts **24**, having a thickness of about 140Å, were then deposited on all regions of the film to complete the Schottky photovoltaic devices **20** of Figure 3.

Many of the devices **20** were then measured, before and after a 3 day of light soaking condition, with about 100 mW/cm of white light from a multi-vapor metal-halide lamp source. After deposition, all devices which had not been exposed to the ultraviolet light illumination step had an open-circuit voltage of 0.48 to 0.49 under 1 sun of white illumination. The ultraviolet illuminated and etched devices were inferior, having voltages in the range of about 0.44 to 0.46. After illumination stress, all devices which had not been exposed to ultraviolet light showed an approximately 0.47 volts due to the Staebler-Wronski degradation effect. However, devices treated with the ultraviolet light illumination and etch steps, according to the method of the invention, actually demonstrated an improvement upon subsequent light soaking, to about 0.49 volts. These results demonstrate that the expected improvement in stability was due to the ultraviolet and etch treatment steps, in sequence, according to the method of the present invention.

While the present invention has been illustrated and described with reference to particular structures and methods of fabrication, it will be apparent to those skilled in the art that

other changes and modifications can be made therein, within the scope of the present invention as defined by the appended claims.

I Claim:

1. A method of producing an amorphous hydrogenated silicon film resistant to metastable degradation, comprising the steps of:

(a) growing a hydrogenated amorphous silicon film, the film having an exposed surface;

(b) illuminating the surface with an essentially blue or ultraviolet light to form high densities of a light induced defect near the surface; and

(c) etching the surface to remove the defect.

2. The method of claim 1 further comprising using the amorphous hydrogenated silicon film in an electronic, optoelectronic, or photovoltaic device.

3. The method of claim 1 wherein the defects are in a near-surface region extending 1,000-10,000Å into the film surface.

4. The method of claim 1 wherein etching comprises using a liquid etchant to remove 500 - 10,000Å of the surface.

5. The method of claim 1 wherein etching comprises using a reactive hydrogen in a plasma or chemical vapor deposition reactor to remove 500 - 10,000Å of the surface.

6. The method of claim 1 further comprising after etching, repeating the steps of illuminating and then etching for a plurality of cycles wherein a population of a two-hydrogen complexes is increased in a bulk of the film.

7. The method of claim 6 wherein the plurality of cycles is for a number sufficient to reduce the hydrogenated amorphous silicon film to a predetermined thickness.

8. A hydrogenated amorphous silicon film produced according to the method of claim 1.

9. A hydrogenated amorphous silicon film produced according to the method of claim 3.

10. A hydrogenated amorphous silicon film produced according to the method of claim 6.

11. The method of claim 1 wherein growing, illuminating, and etching are performed as steps in an a-Si:H film deposition process.

12. The method of claim 3 wherein growing, illuminating, and etching are performed as steps in an a-Si:H film deposition process.

13. The method of claim 6 wherein growing, illuminating, and etching are performed as steps in an a-Si:H film deposition process.

14. The method of claim 1 wherein the a-Si:H further comprises an alloy selected from the group consisting of a-SiGe:H and a-SiC:H.

15. The method of claim 3 wherein the a-Si:H further comprises an alloy selected from the group consisting of a-SiGe:H and a-SiC:H.

16. The method of claim 6 wherein the a-Si:H further comprises an alloy selected from the group consisting of a-SiGe:H and a-SiC:H.

17. The method of claim 9 wherein the a-Si:H further comprises an alloy selected from the group consisting of a-SiGe:H and a-SiC:H.

ABSTRACT OF THE INVENTION

A method of producing a metastable degradation resistant amorphous hydrogenated silicon film is provided, which comprises the steps of growing a hydrogenated amorphous silicon film, the film having an exposed surface, illuminating the surface using an essentially blue or ultraviolet light to form high densities of a light induced defect near the surface, and etching the surface to remove the defect.

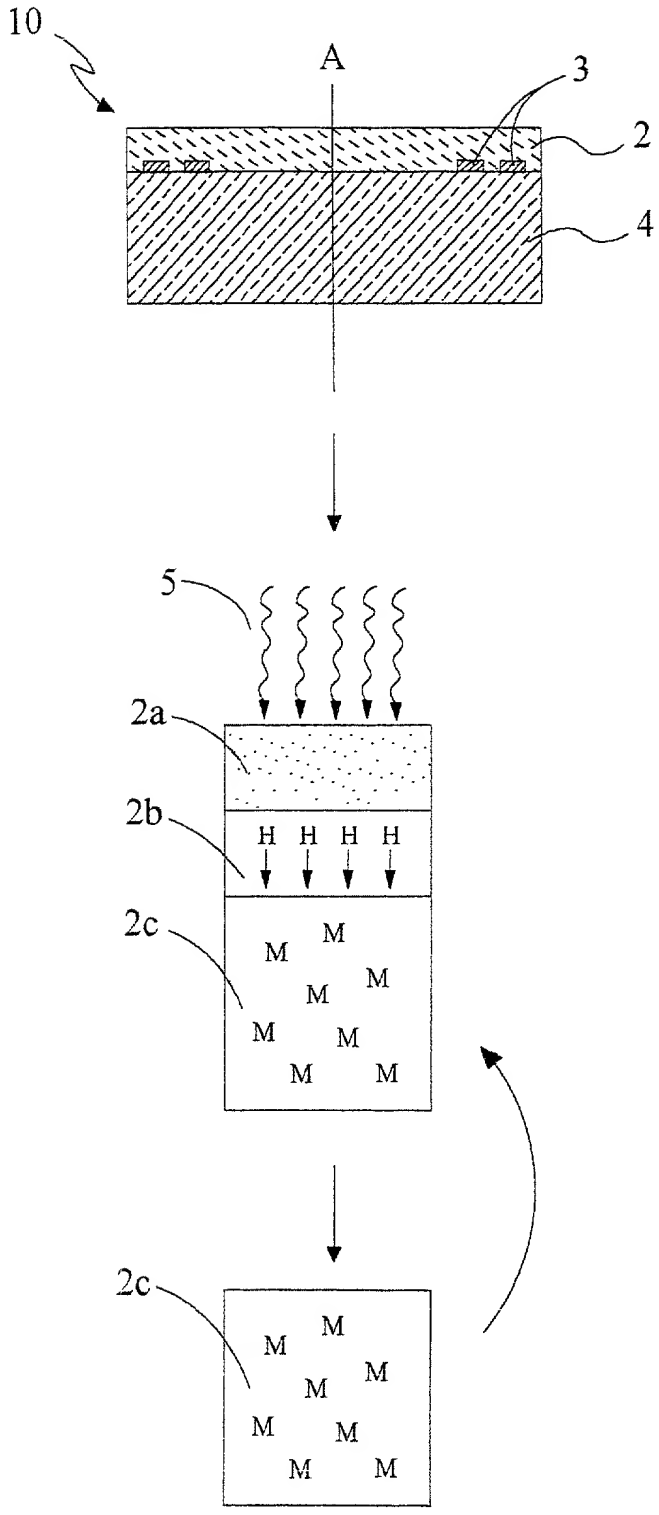


Fig. 1

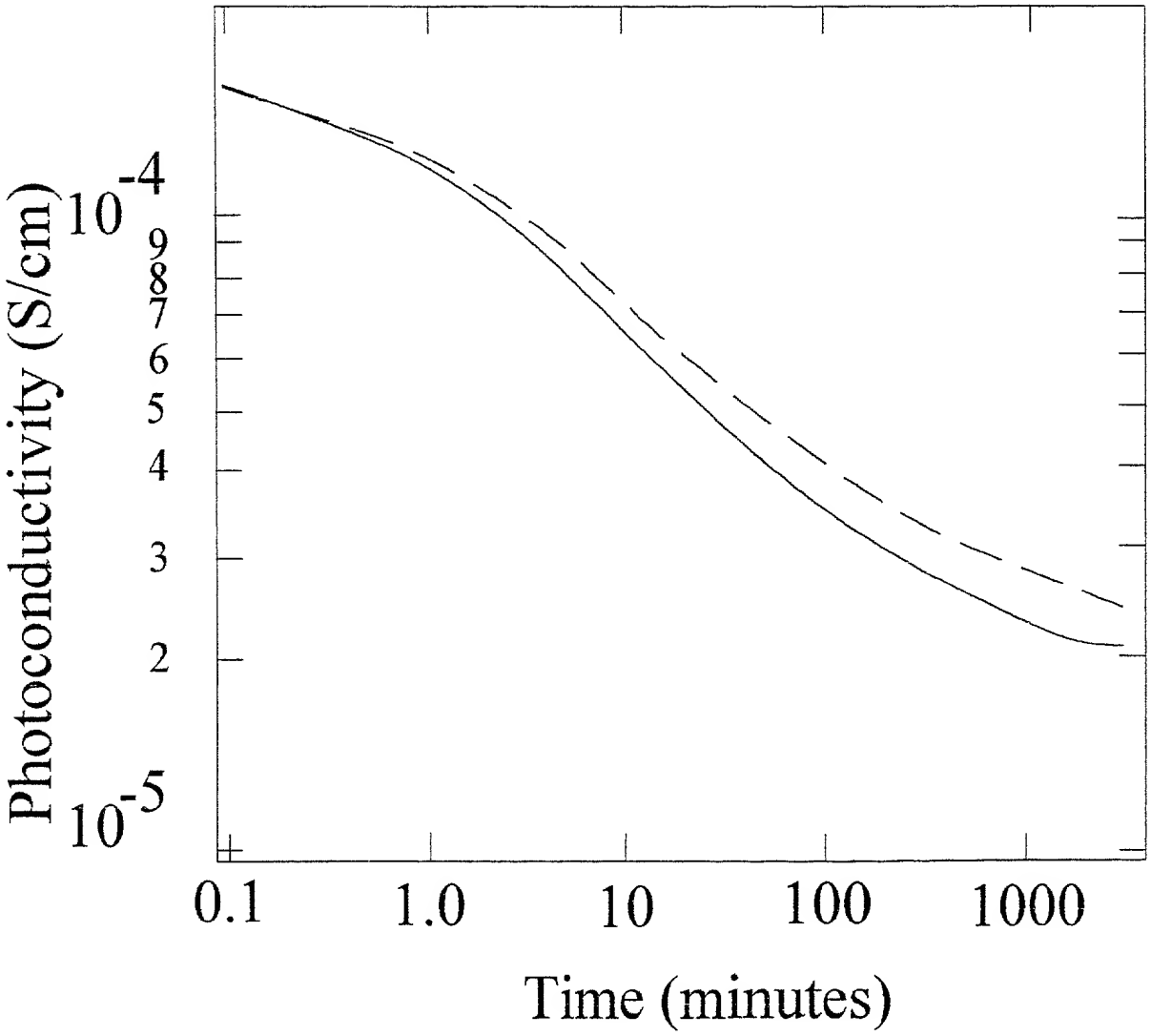

Photoconductivity (S/cm)
10-4
9
8
7
6
5
4
3
2
10-5
0.1
1.0
10
100
1000
Time (minutes)

Fig. 2

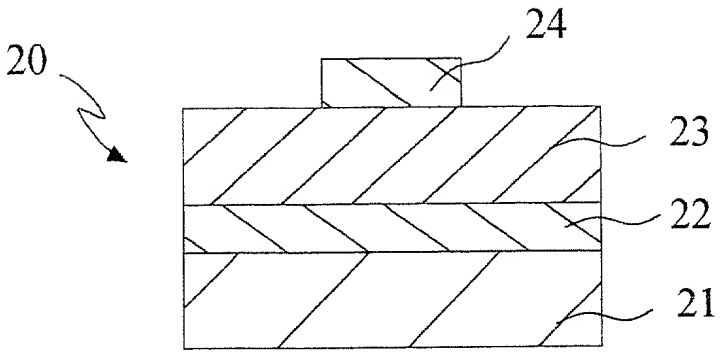


Fig. 3

PTO/SB/O 1 A (1 0-00)
Approved for use through 10/31/2002. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

As the below named inventor(s), I/we declare that:

This declaration is directed to:

☒ The attached application, or

☐ Application No. _____ , filed on _____

☐ as amended on _____ (if applicable);

I/we believe that I/we am/are the original and first inventor(s) of the subject matter which is claimed and for which a patent is sought;

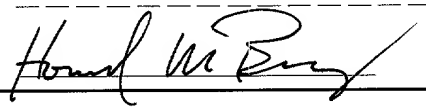
I/ we have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment specifically referred to above;

I/we acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me/us to be material to patentability as defined in 37 CFR 1.56, including material information which became available between the filing date of the prior application and the National or PCT International filing date of the continuation-in-part application, if applicable; and

All statements made herein of my/own knowledge are true, all statements made herein on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. 1 00 1, and may jeopardize the validity of the application or any patent issuing thereon.

FULL NAME OF INVENTOR(S)

Inventor one: Howard M. Branz

Signature:  Citizen of: USA

Inventor two: _____

Signature: _____ Citizen of: _____

Inventor three: _____

Signature: _____ Citizen of: _____

Inventor four: _____

Signature: _____ Citizen of: _____

☐ ☐ Additional inventors are being named on _____ additional form(s) attached hereto.

COMBINED DECLARATION AND POWER OF ATTORNEY

As the below named inventor(s), I (we) hereby declare that:

My (Our) residence, post office address and citizenship(s) are as stated below next to my (our) name(s).

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

METHOD FOR IMPROVING THE STABILITY OF AMORPHOUS SILICON

the specification of which (check one)

☒ is attached hereto ☐ as filed on _____ as Serial No. _____

and was amended _____

I (We) hereby state that I (we) have reviewed and understand the contents of the above-identified specification, including claims, as amended by any amendment referred to above.

I (We) acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, § 1.56(a).

I (We) hereby claim foreign priority benefits under Title 35, United States Code § 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

PRIOR FOREIGN APPLICATION(S)

Number	Country	Filed (Day/Month/Year)	Priority claimed Yes	Priority claimed No
			☐	☐

I (We) hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s) listed below and insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I (we) acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, § 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

Serial No.	Filing Date	Status
60/165,751	11/16/99	Pending

POWER OF ATTORNEY: As the named inventor(s), I (we) hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

Names and Registration Nos.		Names and Registration Nos.
Paul J. White	30,346	
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Send Correspondence to:	Direct Telephone Calls to: (Name and Telephone Numbers)
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We hereby declare that all statements made herein of our own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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